The Polyvagal Theory and a more sympathetic awareness of the ANS

(*after Porges et al*)

This paper is linked to A7 in this series – and it may be helpful to look at A7 first. Porges is one of the world experts on the nature of the Autonomic Nervous System; the Polyvagal Theory is an attempt to make sense of some of the previously unrealised complexities of the ANS – in particular of the un-myelinated and myelinated vagal systems of the Parasympathetic Nervous System (PSNS) – and the relevance of these to human suffering and effective therapies. For the sake of clarity and understanding, what follows is highly simplified.

Contents

1. Introduction

The stress response is often thought of simply in terms of the Sympathetic Nervous System (SNS) and Adrenaline. It is actually more complex than this, and in A1 of this series we discussed:

i. The Type l Stress Response involving SNS and adrenaline.

ii. The Type ll Stress Response involving the release of cortisol (by the hypo-thalamic-pituitary-adrenal-cortex pathway: see Ross 2010).

iii. The Tend and Befriend Response, in which rather than fleeing from danger "females of many social species respond to challenges to homeostasis with affiliate and nurturing behaviours……. and [that] this profile depends on stress-responsiveness hormones generally ignored by the Cannon school, namely, vasopressin and oxytocin." (Sapolsky 2007 p 608, referring to the work of Taylor et al 2001; see also A1 in this series). These affiliative and nurturing behaviours will involve the Parasympathetic Nervous System (PSNS).

Figure 1
Three types of response to stressors / danger

In this paper we will focus on four basic modalities that we normally operate within; two are specifically related to threats (both external and internal); the other two come to the fore when we are not under threat. These are summarised in Figure 2.

Emotional Modality	Associated mental state / EONS	*ANS*
A. Safety	Optimal arousal; social engagement; nurturing. Positive Affect; CARE[1] circuits	***PSNS*** – *myelinated VAGAL (Ventral Vagal System – Nucleus Ambiguus)*
B. Reward	Approach behaviour & SEEKING circuits Positive Affect	***SNS*** – *myelinated*
C. Danger	Attack or Avoid; fight / flight. Negative Affect. RAGE / FEAR	***SNS*** – ***myelinated***
D. Life Threatening	Immobilisation / Freeze. Shut down of system; appear dead.	***PSNS*** – *un-myelinated VAGAL (Dorsal Vagal System)*

Figure 2
Four Fundamental Emotional modalities
Sources include Porges 2001, 200, 2012; Schore 2009; Lynch 2011

Comments on Figure 2. All classifications of natural systems are simplifications of the true nature of nature.

- EONS: Emotional Operating Neuro Systems (Panksepp 1998)
- Myelinated neurones transmit messages far faster than non-myelinated neurones (discussed in A7).
- Then un-myelinated vagal system is activated not just in Life Threatening situations but also in, for example, nursing mothers and in child birth – see Porges 2009 and A7 for further details.
- The Tend and Befriend Response mentioned in Figure 1 is not specifically represented in Figure 2 – but it embraces aspects of B (approach behaviour and positive affect).
- Note in particular that activation of the SNS may be associated with negative affect situations (C) or positive affect situations (B). These positive affect / SEEKING system / dopamine dependent modalities also embrace:
  - i. PLAY (see Panksepp 1998; 2009; Panksepp & Biven 2012; and A7);
  - ii. The vital mother – infant dyad (see Schore 2003B; 2003C; and Ross 2010 – Essay 5: "Affect Regulation, the Infant-Mother Dyad, and Autogenic Therapy".

[1] This paper follows Panksepp's 1998 notation (using all capitals) when referring to specific Emotional Operating Neuro Circuits (or Systems – EONS). So we have, for example, FEAR circuits, PLAY circuits etc; these are discussed further in B3 Parts l & ll of this web series.

The perception (or neuroception[2]) of 'manageable' Danger in Figure 2 activates the flight / fight response and thus the SNS and Type I and Type II Responses summarised in Figure 2 as C. The Life Threatening modality also reflects danger, but here the danger is so overwhelming (D) that it is associated with the Freeze response[3]. The Freeze response is mediated not by the SNS, but rather by a special branch of the (um-myelinated) Parasympathetic Nervous System (PSNS) emanating from the Dorsal Vagal Complex in the brain (see A7 for further details). This is part of the polyvagal understanding of the PSNS (i.e. that there is more than one vagal system).

The Stress Response used to be envisaged as embracing the fight / flight / freeze responses. This is fine as a sort of short hand, so long as it is realised that it involves different systems:

- **Flight**: mediated through the SNS and associated with the FEAR System (Panksepp 1998).
- **Fight**: mediated through the SNS and associated with the RAGE system – Panksepp op. cit.
- **Freeze**: mediated through the PSNS un-myelinated Dorsal Vagal system (with efferent fibres originating in the Dorsal Motor Nucleus – DMNX: see Figure 5 of A7 on page 12); the freeze response is activated in life threatening situations, and is better adapted for reptiles than for mammals / primates / humans (Porges 2009).

2. The Polyvagal Theory (Porges 2001; 2009; 2011)

It had previously been assumed that the PSNS, in the context of the vagus nerve, was uni-modal – i.e. that there was just one two-way-system communicating from the brain to the organs, and from the organs back to the brain. In terms of the efferent fibres, we now know there are two distinct PSNS pathways outlined below.

Note that the vagal PSNS is a two way system with efferent fibres going to the organs, and afferents returning to the brain to give vital information regarding the state of the body / organs: 80% of vagal fibres are afferent (Porges 2011 p 27, referring to the work of Agostoni et al 1957).

i. The Myelinated System

This is the classic (in terms of the history of neuro-physiology) myelinated pathway with the neurones originating in the Nucleus Ambiguus (centred in the Ventral Vagal Complex) – that innervates the heart and bronchi (and organs above the diaphragm) via the fast myelinated nerve fibres. It is part of the Safety, Contentment, and Social Engagement system (A in Figure 3, and Figure 6 in A7).

The effect of this myelinated efferent system has been crucial to mammals. During expiration, when there is no external (or internal) threat, these myelinated fibres to the heart slow the heart (Sinus Arrhythmia). Without this, our resting heart rate would be much faster, as the inherent rhythm of the sino atrial node is fast. This rhythmic slowing of the heart is sometimes called the vagal brake – (see Figure 1 of A7; and Porges 2009).

[2] Neuroception is (usually) the more appropriate term in this context (Porges 2011 p 58-59). Perception implies conscious awareness; the flight / fight response is initially activated unconsciously (LeDoux 1999 – and see B10: (Snakes, Conditional Stimuli, and Equanimity – *Approaches to treating mind-body disturbances*) in this series.

[3] Until coming across the Polyvagal theory, I had never quite understood how the freeze response fitted in with the fight / flight response.

The development during evolution of this myelinated efferent system became crucial for the sophisticated Social Engagement system of mammals – and particularly primates and humans (Porges 2011). The myelinated vagal systems is intimately linked with the facial expression, eye movement and gaze, tone of voice, gesture, head movement, and listening aspects of the social engagement systems (Porges 2011 p 56).

i. The Un-Myelinated System

This system consists of a second PSNS *unmyelinated* pathway centred in the Dorsal Vagal Complex (sometimes referred to as the Dorsal Motor Nucleus – DMNX[4]), that innervates the heart and bronchi – and especially organs below the diaphragm (D in Figure 3 below) [and Figure 5 in A7 on page 11]. It is part of the system that comes into operation when we are faced with some catastrophic danger – such as being eaten by a lion. This is a very ancient system in evolutionary terms, and is non-myelinated[5]. Here our systems shut down and we become immobilised – such as in the Freeze response: for example, a zebra that has been chased by a lion and then caught may at this stage freeze. It can happen that at that moment the lion leaves the zebra to find her cubs to let them know of the feast in store for them: in the moments / minutes that the lion is away, the zebra that has appeared dead (i.e. "frozen") jumps up and runs away. Such a freezing modality in this context would clearly have survival value. However, and despite the example given above of the zebra, while the freeze response was adaptive in reptiles / vertebrates, it can be fatal in mammals and especially humans – for example, the profound shut down of systems can adversely affect the brain's oxygen requirements (see for example A7 in this series – Figure 3 on page 10).

3. Two types of SNS activity

As indicated in Figure 2, there are two distinct operating modes of the SNS, notated as B and C. We are all familiar with the flight and fight response in the face of danger, which is depicted as C in the above Figure, and which we have already briefly discussed. We will now turn our attention to Modality B.

Seeking / curiosity / play / positive affect modality of SNS

Just as important for our overall well being is the so called Reward system that gives us the drive to explore the environment, find food and shelter, and approach for example strangers as a result of curiosity. Panksepp has commented that the Reward system is really a misnomer, and he calls this the SEEKING[6] system – one of the seven basic (primary process) Emotional Operating Neuro Circuits or Systems – EONS (Panksepp 1998; Panksepp & Biven 2012 pp 116-118; also see B3 Part ll in this series). Panksepp comments on his choice of the phrase 'SEEKING system' thus:

> …….SEEKING seems to be a more suitable term for psychology because it implies a distinct psychological dimension as opposed to a mere behavioural process. This harmoniously operating neuro-emotional system *drives* and *energises* many mental complexities that humans experience as persistent feelings of interest, curiosity, sensation seeking, and in the presence of a sufficiently complex cortex[7], the search for higher meaning.
>
> Panksepp 1998 p 145
> *(italics in original)*

[4] Dorsal Motor Nucleus is actually a misnomer as some vagal afferents terminate in it (see Porges 2011 p 46 and A7). Porges mentions that a more accurate name would be the Dorsal Nucleus of the Vagus Nerve (op cit).

[5] So the nerve impulses flow much more slowly than in the myelinated Ventral Vagal Complex system.

[6] Panksepp's notation is to use capitals when describing specific Emotional Operating Neuro Circuits (or Systems); e.g. SEEKING; CARE; PLAY, FEAR, RAGE, PANIC / GRIEF (Panksepp 1998; Panksepp & Biven 2012).

[7] Panksepp's 1998 book is called Affective Neuroscience – *the foundations of human and animal emotions*. He is thus often discussing emotions in the context of other animals, mammals and primates in addition to humans.

This implies that for humans the SEEKING system is also crucial for our overall Well-Being in terms of meaning and our role in society (see also A3). There is evidence that positive affect, which is enhanced by the reward / SEEKING / dopamine system, is associated with:

- Increased access to previous positive memories, while also allowing us to access negative material / memories where these are relevant (Isen 2008 p 548). This is important as one of the features of depression is an inability to access positive memories, and can result in a negative interpretation bias (Dobbin & Ross 2012).
- Flexible thinking, which aids in problem solving and "efficiency and thoroughness in decision making" (Isen 2008 p 548).
- Improved coping strategies – when we are faced with adverse events, positive affect can allow us to cope more effectively with these events – and also reduces defensive reactions (Isen 2008 p 548; Fredrickson 2001).
- Increased resilience (Fredrickson et al 2000; Fredrickson 2001; and 2003 – which includes illustrations).
- Play and PLAY (Panksepp 1998; and B3 Part l and ll of this series).

Meditative type practices such as Positive Mental Training, Meditation, and Autogenic Training can facilitate in the development of positive affect (Davidson 2003A; 2005; Ross 2010; and B5 in this series).

4. Four Basic Operating Emotional Modalities (of Figure 2)

(after Porges, Panksepp, Schore and Lynch)

We are now in a position to integrate the four emotional modalities /systems of Figure 2 in the following format (Figure 3 on page 6):

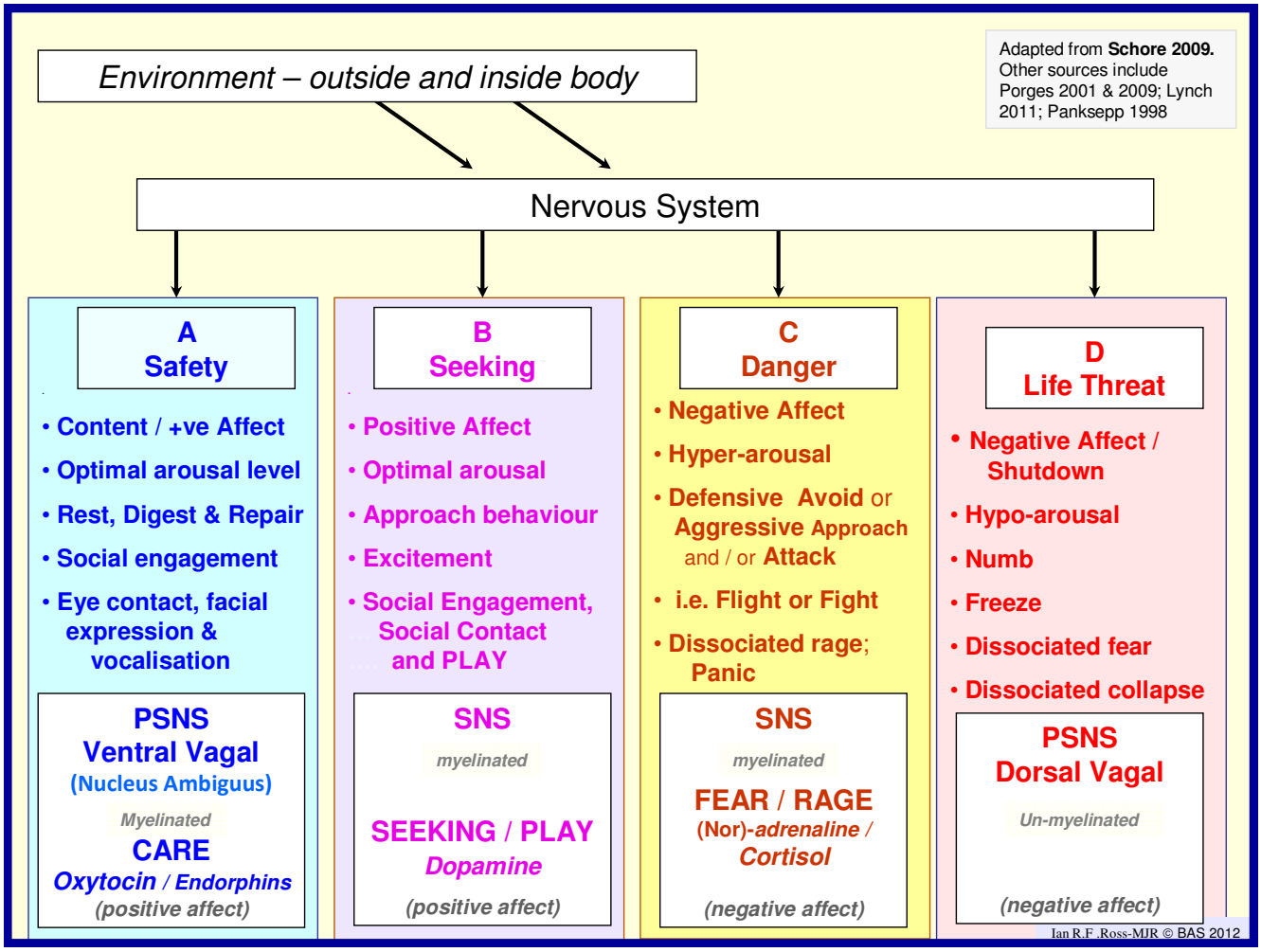

Figure 3
Four of the main Systems that deal with external and bodily stimuli

Comments on Figure 3

Our bodily control systems are sensitive to what is going on in both the external environment (e.g. an external threat), and also to what is going on inside the body, such as: worries about an interview next week, distressing feelings, and the physiological state of our organs / body. These are all are fed back to the brain (see Damasio 1999 pp 286-287 on Background Feelings).

- A. Safety (PSNS): this is modulated in part by the CARE system described by Panksepp, which involves a number of informational substances including oxytocin and endorphins (Panksepp & Biven 2012 pp 291-293).
- B. Seeking (SNS); [designate as the Reward system in Figure 2 on page 2]: the SEEKING system as discussed above; an important neuro-modulator of this system is dopamine. This system will be active in PLAY – see A7.
- C. Danger (SNS): the classic flight (FEAR) and fight (RAGE) response that forms part of the Stress Response. Schore suggests childhood trauma may result in fear and rage becoming dissociated (Schore 2009 e.g. pp 127; 131).
- D. Life Threat (PSNS): this is also part of the Stress Response to overwhelming danger or emotional upset – and is associated with the freeze response; it is non-myelinated. Activation of this system in humans can, needless to say, result in severe psychological trauma that may be resistant to treatment. Note that some forms of dissociation may also occur in this system (as suggested by Schore 2009 p 122).

5. Still Face procedure, Separation Distress, and Grief

General overview

All infants and children – that means all of us – will have suffered some form of Separation Distress in our early years. When a small child is separated (physically on psychologically) from her / his mother (parent figure) this leads to distress which is manifest by loud vocalisations and tears, and this is associated with activation of the danger-precipitated SNS system (Panksepp 1998: 2009; Sunderland 2007; C in Figure 3 above). The distress usually settles with the re-uniting of mother and child in the form of close physical contact and soothing behaviours / vocalisations of the mother (associated with her CARE circuits). Babies and children are unable to self regulate (affect regulate) their distress because their frontal lobes / pre-frontal cortex are not yet sufficiently developed (Sunderland 2006 / 2007). It is probable that the original evolutionary purpose of Distress Vocalisations (e.g. tears / crying / sobbing) was to allow the distressed youngling to communicate their disturbed affect to the parent (Panksepp 1998), who could then take appropriate nurturing action[8].

Repeated activation of the Separation Distress circuits may, over time, lead not to increased vocalisation and distress (SNS danger activation), but rather to the desperation and despair of the Life Threatening system – with activation of the un-myelinated dorsal vagal PSNS (Figure 3). So the child that is left to cry and cry, and eventually becomes quiet, is not quiet because the distress has been released by tears – but quiet because activation of the un-myelinated vagal PSNS has resulted in negative affect and shut down, hypo-arousal, "collapse", and a feeling of being totally abandoned.

A glimpse of the distress engendered when a mother withdraws psychologically from her infant is given in the "Still Face" procedure developed by Tronick. He has filmed mothers interacting with their small children, and then for a fixed period of time – two minutes – the mother stops interacting and becomes completely still with an emotionless face (Tronick 2007 pp 249-292; Tronick 2010; Schore 2009 p 122). The child becomes understandably distressed, with activation of the distress side of the SNS. This quickly settles when the mother re-establishes normal interactions with her child. If the still face experiment is continued for longer, the child switches from SNS distress into the Life Threatening collapse of the un-myelinated vagal PSNS – a terrible event for the child. Schore describes this thus:

> This stress response (i.e. SNS distress) is then followed by bodily collapse, loss of postural control, withdrawal, gaze aversion, sad facial expression, and self-comforting behaviour.
>
> Schore 2009 p 122

In situations where the parent is, for whatever reason, unable to be the "psycho-biologically attuned"[9] parent (Schore 2003B p 19), then the child's development will be adversely affected – both psychologically and in terms of developing brain structure:

> If children grow up with dominant experiences of separation, distress, fear and rage, then they will go down a bad pathogenic development pathway, and it's not just a bad psychological pathway but a bad neurobiological pathway[10].
>
> Watt 2003 p 109;
> Quoted by Schore 2009 p 123

[8] "It may be that the original evolutionary purpose of tears / crying / sobbing was to allow the distressed youngling to communicate their disturbed affect to the parent"; this puts a slightly different perspective on the Autogenic Training (Luthe) Intentional Crying Exercise (see also Hill 1974 p 135).

[9] The modern equivalent to Winnicott's "good enough" parent (Winnicott 1965 pp 145-146)

[10] For a modern and very readable account of the dynamics of the mother infant dyad, see Margot Sunderland's "What every parent needs to know" (Sunderland 2006 /2007).

So, in the context of the mother-child dyad, we have the following possibilities:

i. Activation of myelinated vagal social engagement system interlinking with:
ii. Activation of SNS in mutual play (with activation of PLAY circuits).
iii. Perceived threat to child (e.g. mother going into another room): activation of Separation Distress – SNS danger system.
    - Note: this is usually quickly followed by a restoration of harmony in the child as the bio-psychologically attuned mother re-engages with her / him – e.g. with a cuddle and a real 'in arms' experience for the child. These dynamics are mediated through the bodily contact of the child with the settled physiological state of the mother whose myelinated vagal PSNS will be transmitted through touch to the child; this will of course be associated with activation of the mother's social engagement system (and CARE circuits).
iv. If the activation of the Separation Distress system in the child is repeatedly neglected for whatever reason – say the mother is severely depressed and / or not psycho-biologically attuned, then the SNS based distress of the child may itself collapse and be replaced by activation of the un-myelinated vagal PSNS – associated with withdrawal / severe negative affect / physical disengagement / collapse.

Historical example of the effects of profound childhood neglect / deprivation

As discussed above, profound emotional apathy may be the end result of inappropriate parenting or total neglect. In these situations, it is probable the un-myelinated vagal PSNS is activated, leading to an emotional shut down. This may well have been one of the main mediators in the severely impaired children / rhesus monkeys described by Spitz, Harlow, Bowlby – and the Romanian orphans – see appendix for details). Tronick has suggested that such severe impairment, caused by repeated episodes of un-resolved separation distress, was at work in the four situations illustrated in Figure 4, and that the subsequent pathological developments (physical and psychological) were mediated through the un-myelinated vagal system, with an associated inhibition of the (self-regulating) myelinated ventral vagal PSNS (Schore 2009 p 122, citing Tronick 2004; and Tronick 2007 pp 490-491).

Figure 4 /

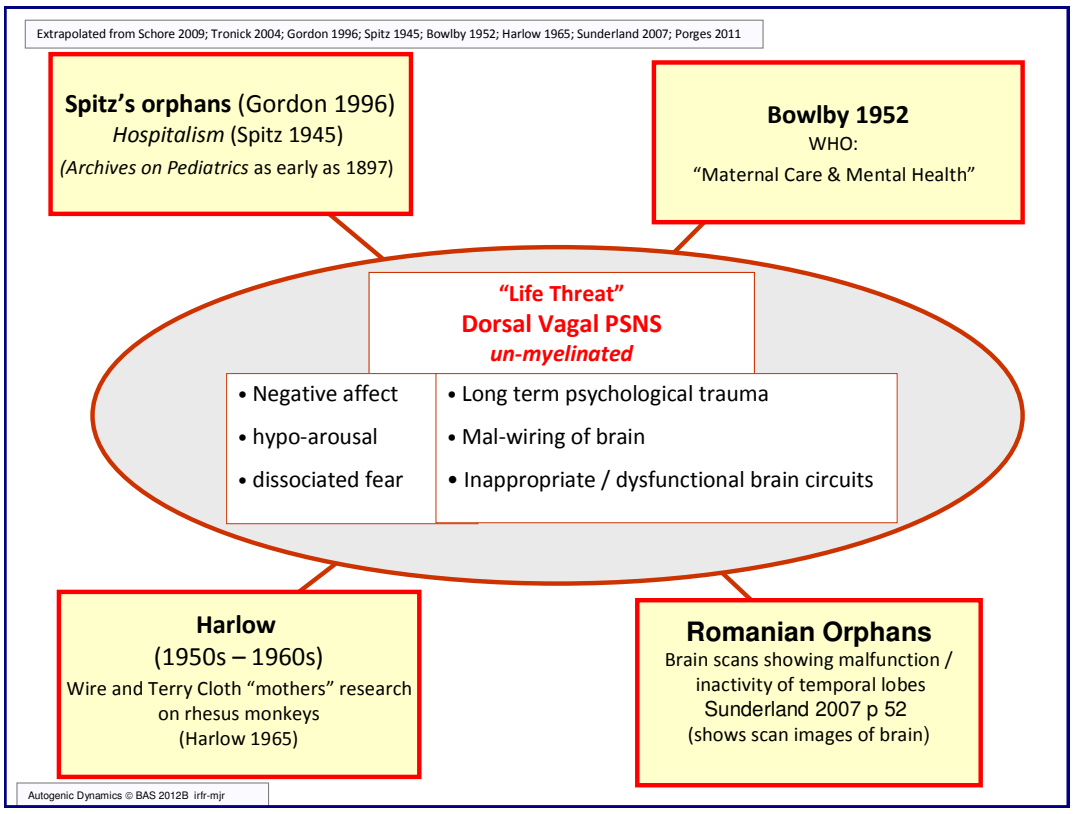

Figure 4
Four historical examples of research on profound deprivation in childhood

Extrapolated from: Schore 2009; Tronick 2004; Gordon 1996; Spitz 1945; Bowlby 1952; Harlow 1965; Sunderland 2007; Porges 2011

The four examples given in Figure 4 are discussed in greater detail in the Appendix, pages 10-11.

Sunderland emphasises again and again the profound importance of child–parent interactions in her book: "What every parent need to know" (Sunderland 2007); [in so far as we have all been children, an even more apt title might have been "What every adult needs to know"].

Loss and grief have been well researched during the last several decades, with the overlapping phases of shock, numbness, disbelief, bargaining, pain, anger, resentment, guilt, depression, and possible resolution / acceptance / "closure" [11]. Grief can activate deep seated neural-circuits, including FEAR, RAGE, and fundamental Separation Anxiety / Distress [GRIEF / PANIC – see Panksepp & Biven 2012; and B3 Part II in this web-series] caused by the loss of a loved one. Endorphin secretion is associated with touch, nurturing, and CARE circuits: following a close bereavement, the production of these endogenous opioids can be curtailed, and lead to something in neuro-physiological terms similar to withdrawal symptoms in those addicted to narcotics (Panksepp & Biven 2012 – e.g. pp 325-328).

In terms of the Polyvagal theory, Separation Distress resulting from the loss / death of a loved one may result in the mobilisation of the SNS fight / flight system, leading to a hypervigilant state associated with feelings of distress, depression, and negative interpretation bias (Dobbin & S. Ross, 2012). Such hypervigilant states are not compatible with well being (see also B10 & B11). On the other hand, grief can go down the path not simply of reactivating our Separation Anxiety neuro-circuits, but then go on to end up on the path of hopelessness and giving up – which may be associated with the un-myelinated vagal PSNS. There may of course be few opportunities, for those who are elderly and have lost their partner, to recreate the nurturing and close physical comfort that in the past has sustained

[11] For a discussion on the possible impossibility of "closure", see Melnick & Roos 2007.

them in times of distress. Such nurturing is also associated with the release of oxytocin[12], a healing informational molecule (Sunderland 2007; see also Pert 1997).

6. Potential activators of the Myelinated Vagus and Social Safety System

In our day to day lives we can become distressed by both external and internal stressors (e.g. working excessive hours and having unresolved emotional issues respectively). These can activate our danger modalities (Figure 2) such as the FEAR, RAGE, or GRIEF systems – which tend to be associated with social disengagement (at least in a positive affect sense).

On the other hand, there are a number of ways we can activate the safety and inner nurturing system – which in turn will tend to lead to increased Social Engagement (see Figure 1 of A7, page 4). Some of these ways are summarised in Figures 5 and 6 below

Example of activity	comments
Stroking a pet	
Gazing at a picture of someone dear to us	
Giving ourselves a firm and gentle hug with both arms	
A warm temperature	
Changing facial expression: • Eye-brow wag • Half-smiling	 i.e. raising eyebrows several times in a playful way especially just after waggling our eye-brows.
Changing body posture – e.g. open hands	While standing, we gently turn our hands so the palms are facing forward; keep this posture for half a minute or longer.
Conscious deliberate slow breathing…….	…. With, in particular, a long out-breath, in which we can allow a gentle smile to develop.
Mental Training (e.g. Meditation; PMT[13]**; Autogenic Training)	
Mindful eating	Gentle chewing activates the Ventral Vagal PSNS.

Figure 5
Self generated activations of the Social Safety System
(Based on, and extrapolated from, Lynch 2012 p 46)

Example of activity	comments
Gentle Touch	In the context of someone close to us
Hugs	
Massage	There are many different forms of massage; note that deep pressure can also stimulate the myelinated vagal system.

Figure 6
Activations of the Social Safety System with another Being
(Based on, and extrapolated from, Lynch 2012 p 46)

[12] And endorphins
[13] Positive Mental Training

These various activities all have the potential to stimulate the myelinated vagal system, which can both induce both the Relaxation Response (Benson 1975), and facilitate, over time, our Social Engagement System (Porges 2009; 2011). This in turn can lead to activation of our SEEKING system (and the associated release of dopamine). Part of the problem in negative mind states – including depression – is that this social system for fostering relationships is inhibited: and this can make it difficult for us to make meaningful contact with other people.

On the other hand, the activities highlighted in Figure 5 & 6 are associated with the release of various informational substances such as oxytocin, prolactin, and endorphins. Oxytocin acts as an anti-dote to both FEAR and RAGE circuits (Panksepp 1998; and B3 Part ll in this series).

7. Reframing Affect Regulation and the Seven EONS into three basic Modalities –

after Gilbert 2009 and Panksepp 1998

From the perspective of our average day to day living, it may be helpful to reformulate the four domains of Figure 3. Life Threatening situations for most of us, most of the time, are rare. Paul Gilbert's approach focuses on three Affect Regulation Systems, which we will now discuss (Gilbert 2009).

Over aeons of evolution, mammals, primates and humans have developed neuro-circuits that (potentially) enable us to live our lives to the full – and these include the seven primary process Emotional Operating Neuro Circuits (Systems – EONS) described by Panksepp (Panksepp 1998; Panksepp & Biven 2012; and B3 Part l and ll of this series). These seven systems can be placed within a broader classification of just three basic modalities that regulate affect (Gilbert 2009). These are:

i. *The Threat and Self Protect System*. This includes the flight (FEAR) and fight (RAGE) systems; these are sophisticated affect regulation systems that in evolutionary terms evolved to allow us to take appropriate action when faced with danger. The system also includes the GRIEF system, which originally arose from neuro circuits associated with Separation Distress in infants.
ii. *The Incentive and Resource-Seeking System.* The SEEKING system is associated with resource finding (e.g. food; water; shelter; companionship); and overlaps with the LUST / SEXUAL system. Play in children can facilitate in the development of this system, and the SEEKING system and PLAY system overlap to some extent (Panksepp & Biven 2012 p 354). Some circuits of the CARE system also overlap with the SEEKING system (Panksepp & Biven 2012 p 291).
iii. *The Soothing and Contentment (Safety) system* – particularly developed in mammals and humans. This is underpinned by CARE circuits – which, especially in the mother-infant dyad, overlap with play and PLAY.

Figure 7, on the next page, illustrates these schematically.

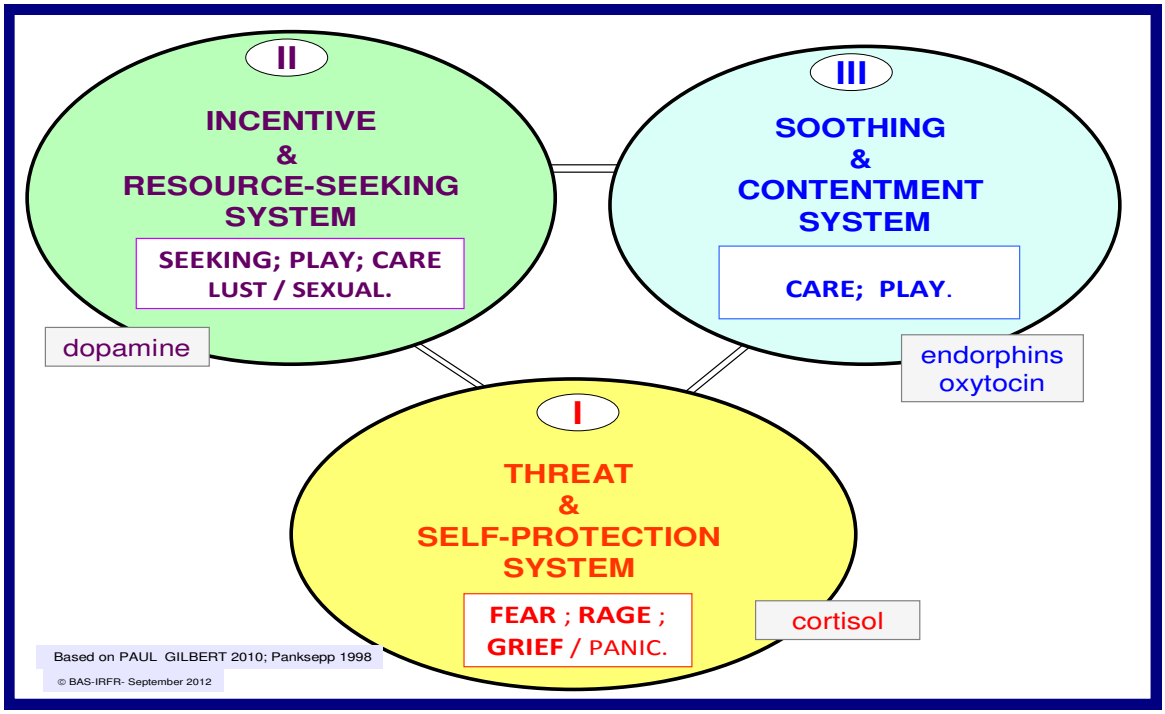

Figure 7
The three basic broad ranging Affect Regulation Modalities or Systems
After Gilbert 2009; Panksepp 1998; Panksepp & Biven 2012

Comments on Figure 7

I. The Threat and Self Protect system is put into action by the Flight (FEAR) and Fight (RAGE) response and associated increased SNS activity. Although adrenaline is involved in this initially, this is usually short lived. Activation of the FEAR circuits can be caused by external threats, internal distress (e.g. unresolved emotional issues), and unconscious factors (see B10). Chronic threat can give rise to persistently elevated levels of cortisol, which can produce long term damage to an organism. In humans this can, over time, lead to depression and memory problems – partly as a result of the death of neurones in the hippocampus (Panksepp & Biven 2012 p 335).

- Separation Anxiety is linked to GRIEF circuits and reduced levels of endorphins. In this context, in adults, the (threat and self-protect) system can become dysfunctional. In the case of a child repeatedly left to cry – i.e. Separation Distress Vocalisations (Panksepp & Biven 2012 pp 320-322) – without being comforted, long term problems may result – such as "an overactive FEAR system……..phobias, obsessions, or fearful avoidance behaviour" (Sunderland 2007 – pp 50 – 53).

II. The Incentive and Resource-Seeking system. This is underpinned by the SEEKING and dopamine systems (Panksepp 1998). Other primary process emotions (EONS) such as PLAY, LUST / SEXUAL, and CARE circuits are interlinked with the SEEKING system. The SEEKING system is the driver of motivation and curiosity.

III. The Soothing and Contentment system. This is underpinned by the CARE circuits and various informational substances including endorphins (endogenous opiates) and oxytocin. These systems are intimately linked with the myelinated vagal system (and the ventral vagal complex) and the Social Engagement system (see Figure 2 and 3 above; and also Figure 1 of A7).

- Many of the activities listed in Figures 5 and 6 have the potential to release endorphins and oxytocin. Thus as human beings we have the potential to care for and nurture ourselves; and in this way be able to increase our ability to engage socially in positive and constructive ways.

8. Autogenic Training, The Safety / Soothing System, and Pre Frontal Cortex Dynamics

Meditative disciplines[14], including Positive Mental Training and Autogenic Training, facilitate a calming of the body-mind and are associated with the dynamics of the Safety modality illustrated in Figure 3 (A). Autogenic Training and Meditation have both been shown to reduce heart rate and respiratory rate (Benson & Klipper 1975; Miu et al 2009); it is probable that this is mediated through the myelinated vagal PSNS, and that the bradycardia (slowing of the heart rate) is linked in with the myelinated vagal brake[15] discussed above (also see A7; and Porges 2009; Porges 2011 pp 20- 51). As a result of this and other affect regulating systems:

> "everything in the periphery becomes quiet"
>
> Wallnöfer 2000
> [with "is" having been replaced by "becomes"];
> Ross 2010 p 24).

This means that hyper-vigilant states – and the related Medically Unexplained Symptoms – may gradually settle, and the equally associated Negative Interpretation Bias (linked with depressive type states) will gradually dissolve to be replaced with life enhancing memories and positive affect (Dobbin & Ross 2012).

It is suggested that regular practice of such Mental Training disciplines (e.g. Positive Mental Training, Mediation, and Autogenic Training) will facilitate our Social Engagement system – thus increasing Social Support and the inter-related benefits (House 1981; Netterstrom et al 1988; Patel 1989; Sunderland 2006 / 2007). Regular practice can allow us to regularly enter, as it were, a safe place within ourselves (the soothing and contentment domain of Figure 7).

Such disciplines also activate the medial Pre-Frontal Cortex, and so the specific nine positive functions described by Siegel (Siegel 2007 pp 337 – 362; see also C2 in this series). These include reductions in fear / anxiety, and an increase in empathy, insight, and emotional balance. Meditative states have also been shown to increase Left Frontal Lobe activity (on EEG), and this acts as an anti-dote to negative and destructive emotions (Davidson 2003B p 335; 2003A; Goleman 2003; and, for a summary see B5 in this series).

Interestingly, fear reduction may also come about through Affect Labelling. It seems that simply labelling a negative affect diminishes "the response of the amygdala and other limbic regions of negative emotional images" (Liebermann et al 2007; C7and B12). Such affect labelling becomes more natural as we develop our "observer" or "witness" role in Autogenic Training; these are also aspects of mindfulness (D1).

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[14] Rinpoche has an interesting comment on our word discipline. "In Tibetan, the term discipline is *tsul trim*. Tsul means 'appropriate or just,' and trim means 'rule' or 'way.' So discipline is to do what is appropriate or just; that is, in an excessively complicated age, to simplify our lives." (Rinpoche 1992; see also Fredrickson 2009).

[15] It was previously assumed that, in terms of relaxation, an increase in vagal tone would always be good. However, this may not be the case. The bradycardia associated with Sinus Arrhythmia that reflects increased myelinated vagal tone can be seen as beneficial to the individual – and is associated with a "frequency common to both respiratory and cardiac systems" (Porges 2011 p49). However, increases in unmyelinated vagal tone (from the Dorsal Nucleus – Dorsal Motor Nucleus – DMNX in A7) can be lethal; in addition, the output from the DMNX "does not convey a respiratory rhythm" (Porges 2011 p 49).

9. Afterword

This second paper on the Polyvagal theory has attempted to integrate Porges's theory with the seven primary process Emotional Operating Neural Circuits described by Panksepp. For health and Well Being, we obviously need our Autonomic Nervous System to be working harmoniously. The SNS is activated in situations of danger, but it also plays a crucial role in aspects of Social Engagement, SEEKING and PLAY. The ancient (un-myelinated) PSNS facilitates organisms – such as reptiles – to survive in life threatening situations (partly through activating the Freeze response); while the newer, myelinated vagal system (PSNS), has been crucial in developing other aspects of Social Engagement – including non verbal forms of communication such as facial expressions and gestures, in addition to facilitating (digestion), rest, and repair.

It is suggested that Mental Training, such as Meditation and Autogenic Training, activate the myelinated vagal system (which is associated with increased Heart Rate Variability), and that this facilitates Social Engagement and the EONS such as PLAY, SEEKING, and CARE circuits.

Appendix /

Appendix
Four examples of emotional deprivation leading to long term psycho-pathology that may involve activation of the un-myelinated dorsal vagal PSNS and loss of the myelinated ventral vagal system

1. Rene Spitz's research

In the 1930s René Spitz, a psychoanalyst, found that infants in "spotless, up-to-date foundling homes" had some difficulty in feeding and developed more slowly than they should. Subsequently, Rene Spitz visited a dilapidated, dirty orphanage in Mexico and, to her surprise, found that the children were, by and large, thriving. She made enquiries, and found that local village women would come in regularly to "feed; fondle, rock and sing to these babies." (Gordon; 1996; pp 131-132). Physical touch and cuddling activates the secretion of oxytocin, which acts as a chemical antidote to stressors (Sunderland 2006).

Spitz subsequently used the term hospitalism to describe the effects of hospitalisation on children when they are not given appropriate physical and emotional support when admitted to hospital (Spitz 1945). The term hospitalism was not coined by Spitz: according to Wikipedia it had been used in an editorial in *Archives on Pediatrics* as early as 1897.

2. John Bowlby, attachment and loss

John Bowlby's pioneering study after World War ll for the WHO: "Maternal Care and Mental Health" (Bowlby 1952) highlighted the grave consequence of inadequate / absent parenting. He continued with this research, some of which was published in his monumental work: *Attachment and Loss* in three volumes (Bowlby 1969; 1973; 1980. Also note Bowlby 1986; 1988).

3. Harry Harlow's research with rhesus monkeys and wire or terry cloth mothers

Harlow was concerned about the effect of psycho-social deprivation as described by Spitz, and Bowlby's initial work on child deprivation. From 1957 to 1963 he carried out research on baby rhesus monkeys in his laboratory (University of Wisconsin-Madison). Initially he had the baby monkeys separated from their mothers and brought up in cells in which there was a surrogate wire monkey and a surrogate terry cloth covered (wire) monkey. The milk was only provided by the wire monkey. The baby monkeys spent most of their time cuddling into the terry cloth monkey, and only approached the wire monkey when they needed a feed. When distressed by a noise or some threat, they always rushed to the terry cloth mother.

In some experiments, the baby monkey had either the wire or the terry cloth surrogate mother – both providing milk. Somewhat curiously, the baby monkeys' weight gain in both groups was similar; however: "the monkeys that had only a wire mother had trouble digesting the milk and suffered from diarrhea more frequently. Harlow's interpretation of this behavior, which is still widely accepted, was that a lack of physically comforting contact is psychologically stressful to the monkeys." (Harlow review in Wikipedia 2012). We now know, of course, that nurturing physical contact promotes the release of oxytocin – and hence well-being.

In subsequent experiments, some of the baby monkeys were then put in a room with no surrogate mother at all; they became very distressed:

> They froze in fear and cried, crouched down, or sucked their thumbs. Some even ran from object to object, apparently searching for the cloth mother, as they cried and screamed. Monkeys placed in this situation with their wire mothers exhibited the same behavior as the monkeys with no mother.
> http://en.wikipedia.org/wiki/Harry_Harlow

Some authorities have been critical of Harlow's methods; be that as it may, his work was ground breaking. During the 1940s and 1950s the behavioural psychologists had had a devastating effect on child rearing practices because they assumed that all that animals / humans need for health is food. Again, quoting from the excellent Wikipedia website on Harlow:

The importance of these findings is that they contradicted both the then common pedagogic advice of limiting or avoiding bodily contact in an attempt to avoid spoiling children and the insistence of the then dominant behaviorist school of psychology that emotions were negligible. Feeding was thought to be the most important factor in the formation of a mother-child bond. Harlow concluded, however, that nursing strengthened the mother-child bond because of the intimate body contact that it provided. He described his experiments as a study of love. He also believed that contact comfort could be provided by either mother or father. Though widely accepted now, this idea was revolutionary at the time.

http://en.wikipedia.org/wiki/Harry_Harlow

Luckily, in this context, we now live in a more enlightened era with the ground-breaking research of the likes of Bowlby (op cit); Harlow (op cit) Panksepp (1998; 2009); Panksepp & Biven 2012; Schore 2003 A,B,C & 2009; Sunderland 2007). We now know that touch and cuddles are vital ingredients of well-being, and are associated with calming informational substances such as oxytocin.

Later studies in which the rhesus monkeys were isolated for six months showed desperate problems when the monkeys were returned to social grouping; this became even worse after twelve months' isolation. After twelve further months, these monkeys had, not surprisingly, not reintegrated – indicating possible life long effects of such deprivation (Harlow et al 1965).

In the summer of 1954 (aged 8) I was admitted to the local hospital with facial burns. The visiting times for children at that time were limited to I think just twice a week – perhaps at week ends. This was presumably justified on the assumptions of the behaviourists and the prevalent feeling of the staff that visiting parents would upset the children.
However, my mother visited me every day; I do not know how she persuaded the staff to waive the visiting rules. May be she was following new ideas in child psychology by the likes of Bowlby and Harlow and that she was therefore able to make persuasive arguments to the staff. In any event, I greatly benefited from these daily visits.

4. Romanian orphans

Following the collapse of the Soviet Union and its satellite states, some orphans found in Romania were in a terrible state. They had been deprived and neglected and abused terribly – one of the results of Ceauşescu's regime. Subsequent brain scans on some of these children revealed that parts of their temporal lobes were inactive – these parts of the brain are vital for "processing and regulating emotions. Temporal lobe inactivity can result in poor social and emotional intelligence" (Sunderland 2007 p 52; this page 52 also reproduces the brain scan images in the deprived orphans compared with those children who have received loving and nurturing parenting.) Figure 5 below gives a stylised representation of the scans.

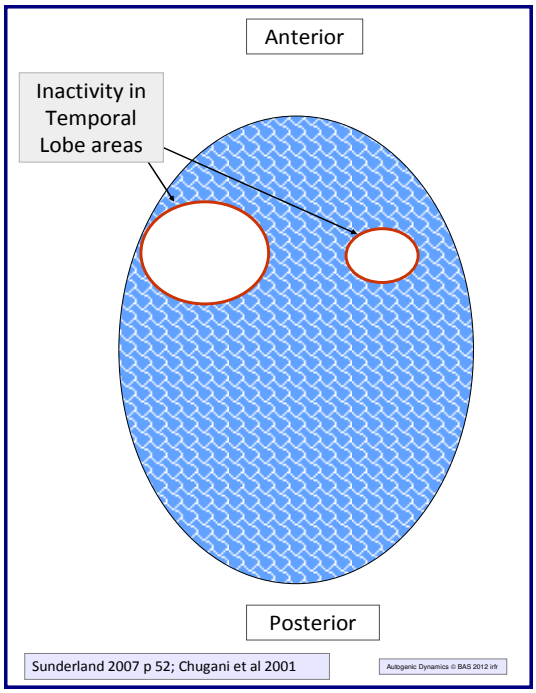

Figure 5

Schematic representation of the inactive temporal lobe areas of the brains in children from the Romanian orphanage.

Comments on Figure 5

Sunderland comments that the temporal lobe area of the brain "is vital for processing and regulating emotions" (Sunderland 2007 p 52).

The figure is a simplified version of the brain scan image reproduced in Sunderland 2007 p 52, based on the original research of Chugani et al 2001.

Children who have received nurturing and loving parenting have normal brain scans with no such areas of inactivity.

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Linked themes in this Autogenic Dynamics section /

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A1	The Stress Response, the Relaxation Response, and the Tend and Befriend Response.
A3	Towards a concept of happiness and well-being
A7	Porges and the Polyvagal Theory – *reflections on clinical and therapeutic significance*
B3	Part I: The Origins of Affect and Affective Neuroscience – *and the misplacing of Affect in the neo-cortex*
B3	Part II: Emotional Operating Neuro Circuits – *a brief introduction to Panksepp's model*
B5	Emotions, Frontal Lobe dynamics, and Autogenic Training
B9	Mental Training, the Pre-frontal cortex, Resilience and Equanimity
B10	Snakes, Conditional Stimuli, and Equanimity – *Approaches to treating mind-body disturbances*
B11	Transforming Distressing Mind-Body-States – *from Negative Ruminations towards Well-Being*
B12	Affect Labelling, Autogenic Training, and reducing Emotional Distress
C2	Mindsight, our seventh sense – *and associated middle pre-frontal cortex functions*
C7	Being in touch with our feelings – Hemispheric Integration *(includes the concept of Affect Labelling)*
D1	Reflections on Foundations for Mindful Living

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